An Innovative Approach to Use Solar Energy Utilising Drinking Bird Principle for Water Lifting in Rural Areas in India

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Abstract

One element of development gap has been scarcity of energy and power supply in the less developed areas in our country. Moreover, within prevailing energy crisis and increasing cost of power generation using fossil fuels or nuclear energy search for unconventional means has almost become an important necessity. The key to increased living standards in any community is the efficient utilization of natural resources. It is therefore, axiomatic that poorer sections of our country must get developed their energy resources to enjoy their lives. Remotely dispersed villages with population of two to three thousand lack conventional sources of energy. Providing them with electricity and other fossil fuels is uneconomical mainly because their demands are very low and many of them are remote from energy producing centres. It appears, development of small indigenous power sources would play important role in rural modernization, which, in addition to increasing agricultural production, would also help restricting migration of rural people to urban cities. Hence, an innovative approach utilising principle of the drinking bird toy has been explored for developing a device using solar energy, which is locally and cheaply available energy source in abundance, for water lifting from nearby canals, and nalas where water level is half to two meters below the ground level. The current article would discuss about the design and performance etc. of the same in detail.

1. INTRODUCTION

Disparity between the material wellbeing among “have” and “have not” nations of the world is one of the most profound facts of our time. One element of development gap has been scarcity of energy and power supply in the less developed countries. Moreover, within prevailing energy crisis and increasing cost of power generation using fossil fuels or nuclear energy search for unconventional means has almost become an important necessity. The key to increased living standards in any community is the efficient utilization of natural resources, both human and physical. A high level of agricultural or industrial production can only be attained by a community which is able to produce amounts of energy many times more the sum total of muscular capabilities of its members. It appears, therefore to be an accepted fact that poorer sections of the world in general and our society in India in particular must develop their energy resources before they could

be able to enjoy the fuller lives.In India, providing remotely dispersed villages with electricity and other fossil fuels is uneconomical mainly because their demands are low and many of them are remote from energy producing centres. For ease in increasing agricultural production, by efficient and economic irrigation, drainage and mechanization and also agro- based industries, it would be imperative that power be made available at village level.

Thus it appears, the development of small indigenous power sources would play an important role in rural modernization, which in addition to agricultural development would also help restricting migration of rural people to urban cities. This work is concerned with the low power generation for developing areas. An innovative opinion of the drinking bird has been tried to develop a device utilising solar energy which is locally and cheaply available energy source in abundance for water lifting from nearby canals, and drains etc. where water level is about half to two meters below the ground level. The primitive methods viz; swing basket, counter poise lift, Archimedean screw, and paddle wheel etc. are operated by manual labour or in some cases by animals. The power obtainable from human beings and animals can be replaced by indigenously available sources of energy such as running water, wind, agricultural waste materials, and solar radiation. The device should have comparatively low initial cost, low operating cost, and should require little maintenance [1].

2. MATERIALS AND METHODS

Conceptually when the head is dry, temperatures in the body and head chambers remain the same and the bird remains in the near vertical position. But once the fabric material over the head is wetted, evaporative cooling occurring at the head would reduce the pressure in the head vapour space. The difference of pressures in the body and head would cause the liquid from body to rise through the inter connecting tubes. This would continue till enough liquid has risen, causing the bird to tip forward. When the bird reached a certain inclination, the liquid seal at the bottom end of the tube would break. The resulting instability of the liquid column in the tube caused the liquid to flow down to the body. Two models of solar water lifting device were developed (Model 1 & Model 2 as shown in the figures) utilizing this principle of drinking bird. The performance of both the models were studied and evaluated. The first model, in which the solar heat source was provided near head at the top and sink/body filled with R_{11} fluid at the bottom.The Refrigerant 11 (R_{11}) was chosen as working fluid in this case because the vapour pressure of R_{11} at room temperature was 1.12 kg/cm^2 which was very near to atmospheric pressure, while in case of other refrigerants this pressure was very high. The vapour pressure of R_{11} simplified fabrication and made model lighter; and dp/d_t value of R_{11} was quite low i.e. for a small temperature increase, the increase in vapour pressure was high and also it has been non-corrosive, inert to oils, easily available, non- toxic, non- poisonous and easily detectable for leaks. Equalization of pressures between the vapour from the body entered as bubbles through the liquid column in the connecting tube and as all the liquid in the head flew back to the body, the unit returned to the original near vertical position doing the external work.

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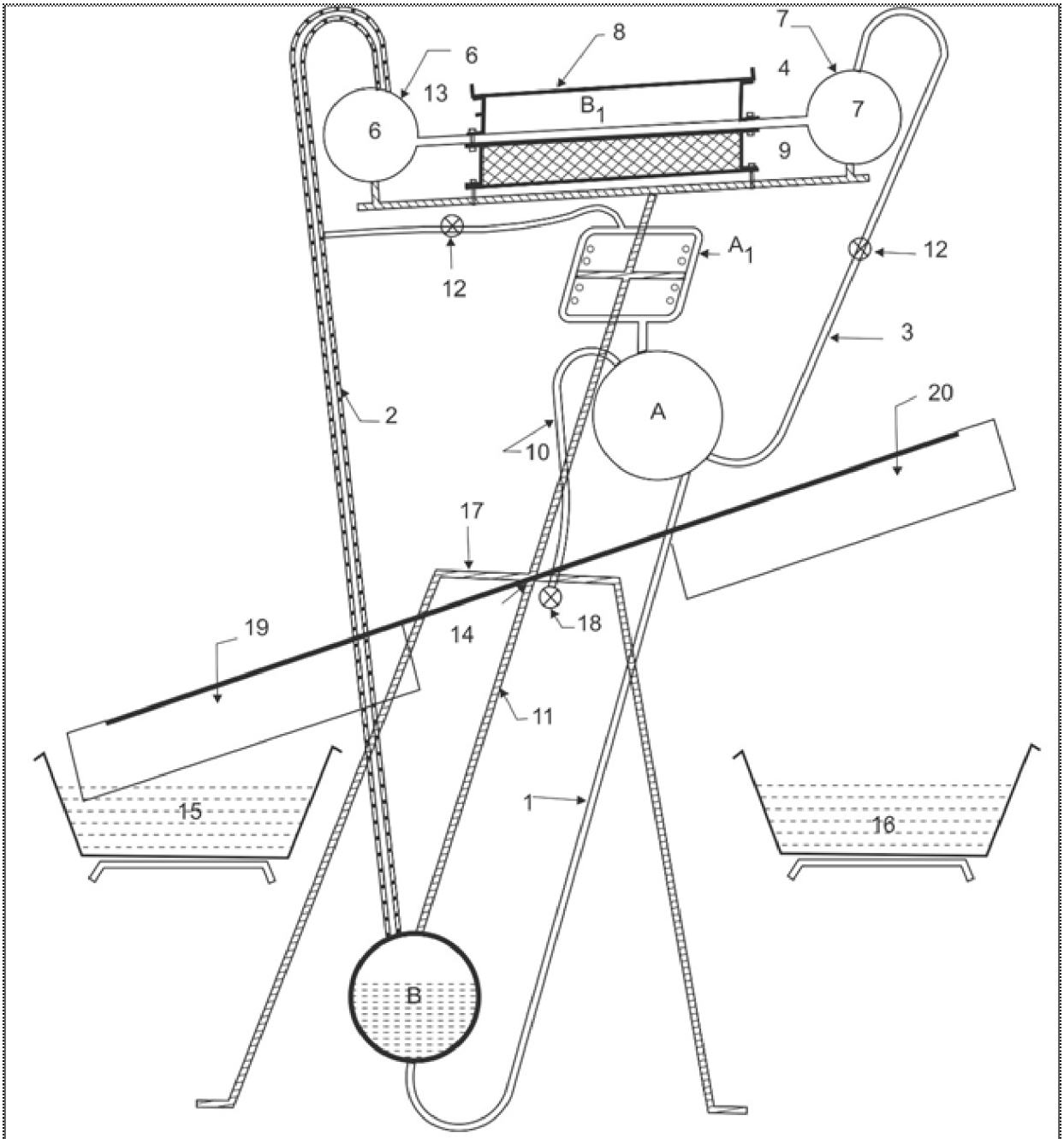
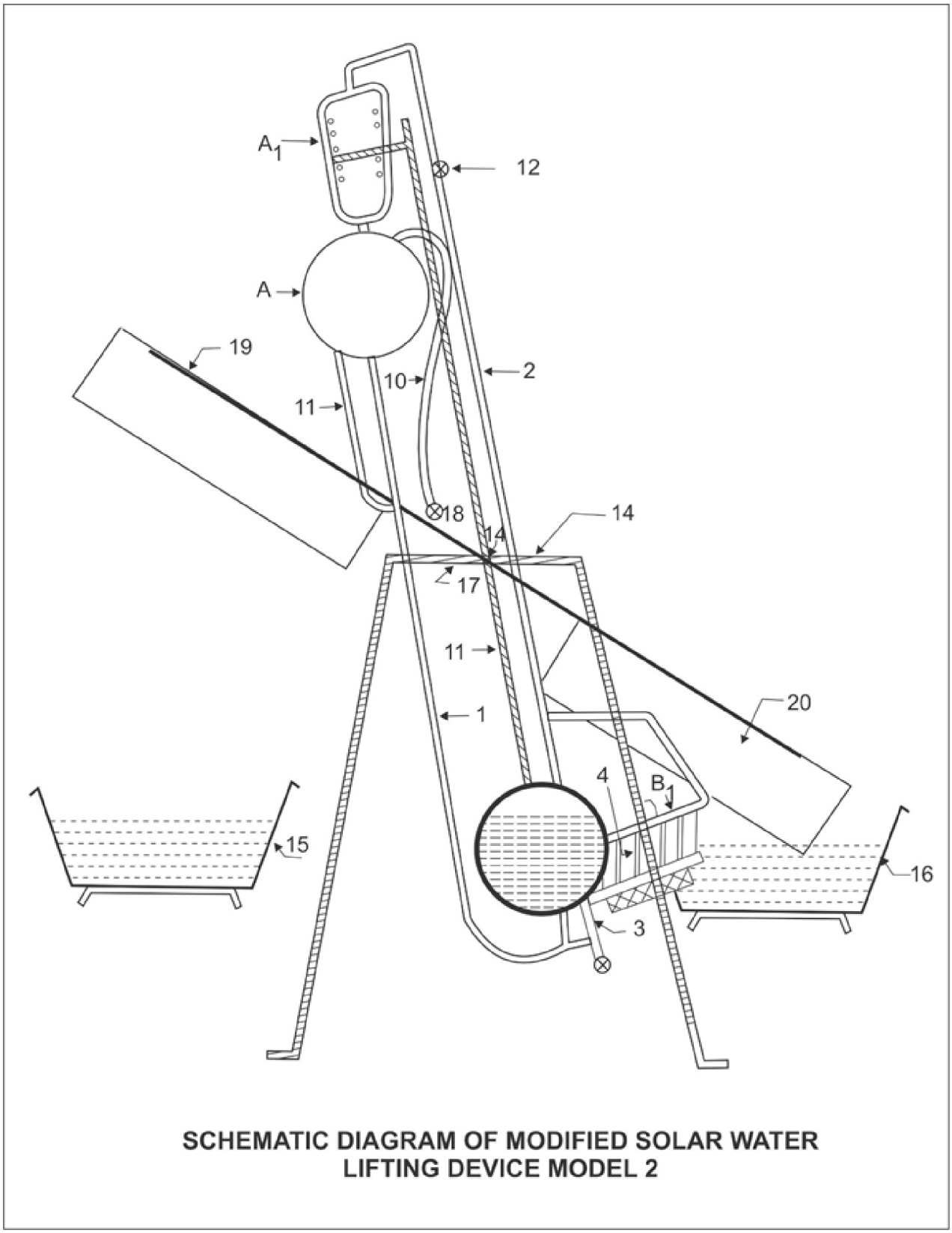


SCHEMATIC DIAGRAM OF THE SOLAR WATER LIFTING DEVICE MODEL I

1 CYLINDRICAL HEAD	10 CHARGING LINE
A1 HEAT EXCHANGER	11 MAIN ANGLE IRON TO HOLD COMPONENTS
B CYLINDRICAL BODY	12 GRAVITY VALVES
B1 SOLAR COLLECTOR	13 FRAME OF SOLAR COLLECTOR
1 LIQUID LINE INSULATED	14 FULL-CRUM
2 INSULATED VAPOUR PRESSURE LINE	15 WATER RESERVOIR
3 LIQUID LINE WHEN A AND 7	16 WATER RESERVOIR
4 0.635 CM F COPPER TUBE ON COLLECTOR PLATE	17 SUPPORTING FRAME
5 BY-PASS VAPOUR PRESSURE LINE	18 HAND VALVE
6,7 SMALL CONTAINER	19 BUCKET
8 GLASS PLATE	20 BUCKET
9 INSULATION	



SCHEMATIC DIAGRAM OF MODIFIED SOLAR WATER LIFTING DEVICE MODEL 2

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Various processes involved in the operations were - heat transfer to mass m in the collector B, at the wet state under constant volume to vapour state, and change of phase by heat transfer at the constant temperature to mass m in collector B. This caused displacement of mass of liquid from the body chamber. Simultaneously, as process took place in B, the mass was cooled under constant volume from one state to another state in head (A) including heat exchanger A_1. And also simultaneously as the second process took place in B, the constant temperature condensation occurred in head and heat exchanger from last state to the original liquid state.

3. APPLICATION OF SOLAR HEAT ENGINE FOR WATER LIFTING

When the system rests in the near vertical position, gravity valve provided on the top nearby heat exchanger remains closed so that when Refrigerant (R_{11}) is evaporated by absorbing heat from solar collector it does not flow through heat exchanger line. Vapour coming out from solar collector flows in the vapour pressure line and presses the liquid to rise up into the head chamber by liquid line. When liquid rises in the system its centre of gravity rises above the fulcrum and its potential energy increases and the system tips forward. When this tipping forward reaches a certain inclination i.e., near horizontal position, the gravity valve is opened and high pressure vapour starts flowing through heat exchangers and presses the liquid inside the head to flow back into the body chamber. Then centre of gravity of the system is shifted towards body following transfer of the liquid from head to body with respect to the fulcrum produces a backward torque which causes the system to move to near vertical position while also doing external work. In this part of the cycle stored potential energy is made available for the external work. Hence, to meet out the requirements of low power sources for rural sector concept of oscillating heat engine working on drinking bird principle was considered [2,3].

4. CONCLUSION

Two models of solar water lifting device were developed utilizing the principle of drinking bird. The first model, in which the solar heat source was provided near head at the top and sink/body filled with R_{11} fluid at the bottom, did not yield encouraging result mainly because of lack of fluid transfer from sink to head to shift the centre of gravity for tipping forward for doing the work mainly due to to development of lesser energy. In the second model, solar heat source was brought down near the sink/body filled with R_{11} fluid. In the hot sun the unit was tested. This also did not give encouraging result mainly because the power developed was found to be insufficient for doing the desired work. Nevertheless, it was thought appropriate to put for the above view points, for furthering the R & D works to successfully develop such devices for remote villages which may be of great help to the farmers.

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